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Assessment of Temporal Patterns in Winter Diet of Sea Otters (*Enhydra lutris*) by Scat Analysis in Kachemak Bay, Alaska (2008-2009)

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INTRODUCTION

Long-term monitoring of a keystone species' diet is valuable and contributes to our understanding of shifts in the structure of an ecosystem. Sea otters eat a wide range of marine invertebrates and their diet varies by the type of habitat available. The relationship between sea otter foraging and ecosystem structure has been best studied in habitats which are urchin and kelp dominated (Estes and Palmisano 1974). Less is understood about prey and ecosystem dynamics in soft-sediment habitats (Kvitek and Oliver 1988). Kachemak Bay, Alaska, is primarily a soft-sediment basin where the sea otter population increased from <1,000 in the 1990s to 3,600 in 2008 (Gill *et. al* 2008). Methods for assessing sea otter diet include visual observation, scat analysis, and, recently, emerging techniques in whisker isotope analysis. All methods have some biases in identification of sea otter prey. Scat collection is limited in our study area to the winter months when sea otters haul out more frequently and in greater concentrations (pers. observation). In this study, we evaluate scat analysis as a low-cost tool to monitor long-term trends in the winter diet for sea otters in Kachemak Bay.

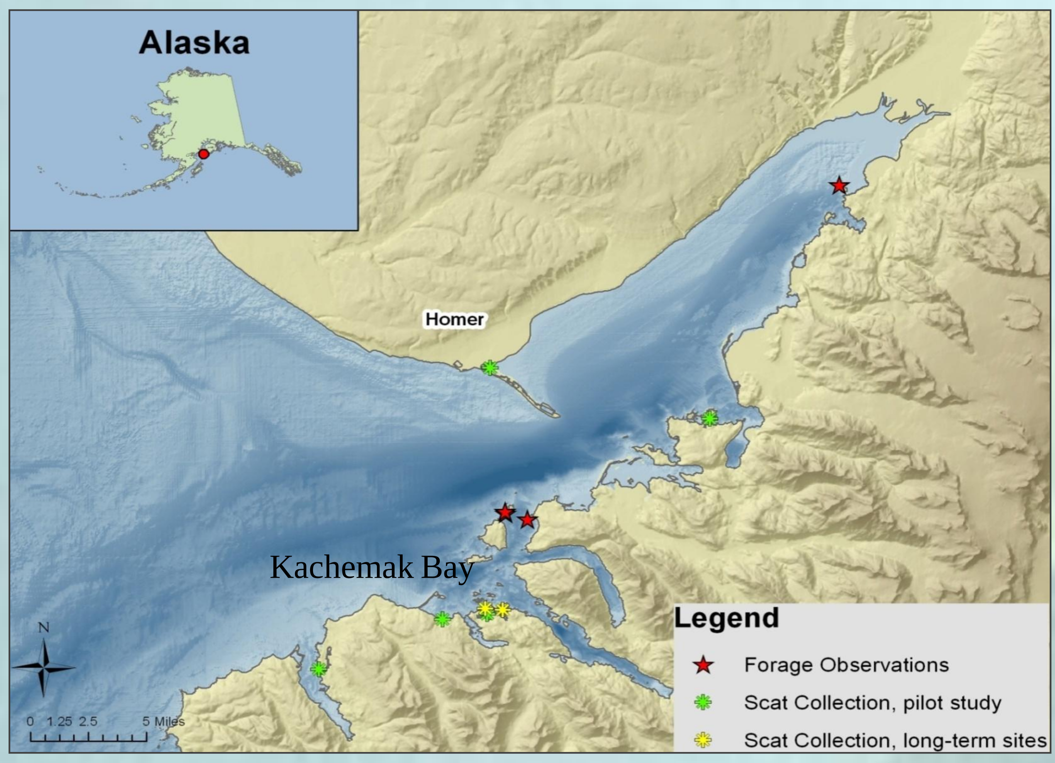

Figure 1. Locations of forage observations and scat collection sites in Kachemak Bay, Alaska, 2008-2009

METHODS

Scat Collection:
In March 2008, we began a pilot study to assess the feasibility of determining sea otter diet by scat collection in Kachemak Bay. Nine locations were assessed and of those, two female/pup haul out sites were selected as long-term monitoring locations (Fig. 1). Both sea otter and river otter (*Lontra canadensis*) scats were collected. During October 2008 – May 2009, we collected scat samples systematically (One week accumulations at approximately monthly intervals). All scats were collected, labeled with the date and location, and frozen until processing.

Sample Processing:
Scat samples were washed with fresh water through a high pressure hose using one large mesh and one fine screen sieve. Air dried samples were sorted by hand to the nearest discernable taxonomic level, placed in Ziploc baggies, and the percent volume of each prey type was estimated.

Data Interpretation:
To better understand the utility of scat analysis as a monitoring tool, we include results of foraging observations and telemetry data from other studies in Kachemak Bay.

Otter scat collection

Sample processing

RESULTS

During spring/summer 2008, we collected 142 sea otter and 21 river otter scat samples from nine locations throughout the Bay (Fig. 1). During October 2008 – May 2009, we collected 98 sea otter and 10 river otter scat samples from two long-term monitoring sites. River otter scats have not yet been analyzed. Dominant prey types in the sea otter scat samples at all sites were mussels (41%) (*Mytilus trossulus*), crabs (31%) (including: *Cancer* spp., *Telmessus cheiragonus*, *Pagurus* spp. and probable *Chionoecetes bairdi*), and clams (12%) (including: *Saxidomus giganteus*, *Mya* spp., and *Protothaca staminea*). Other species present throughout the sampling period included urchins (*Strongylocentrotus* spp.), chitons, limpets (*Tectura* spp.), and snails (Table 1). In most cases, the prey was well masticated and we were not able to identify the remains to species. Though not previously known to be sea otter prey in Kachemak Bay, we found fish bones in scat samples collected in both sampling periods. Fish comprised <1% of the total volume in both years (Table 1).

Table 1. Frequency of occurrence and the mean percent volume of prey types in sea otter scat samples collected at haul out sites in Kachemak Bay, Alaska, 2008-2009

	% Freq Occurrence		Mean % Volume	
Prey Type	Spring 2008 (n=142)	Fall 2008-Spring 2009 (n=98)	Spring 2008 (n=142)	Fall 2008-Spring 2009 (n=98)
Mussel	94	93	40	42
Crab	82	80	32	29
Clam	58	61	12	12
Barnacle	40	37	2	2
Urchin	38	42	7	11
Snail	20	26	1	2
Limpet	18	15	1	1
Chiton	13	8	1	1
Unk Bivalve	6	11	1	0
Scallop	6	9	0	0
Unk Prey	4	11	0	0
Fish	4	10	0	0
Horse mussel	4	2	0	0
Shrimp	1	0	0	0
Worm	0	1	0	0
Cockle	0	5	0	0
Sand dollar	0	1	0	0

There were no marked differences in trends in composition or prey diversity between the 2 sites sampled in winter 2008-09, and data were combined. During the systematic sampling period, there was an inverse relationship between proportion of mussel (dominant late fall and spring) and crab (dominant winter and early spring) in the diet. The proportion of clam was also inverse to that of crab but was <20% of the total sample. Proportions of clam, urchin, and other prey fluctuated but remained at low levels throughout the sampling period (Fig. 2).

During summer 2008, we conducted visual observations of foraging otters in a female/pup area adjacent to all winter haul out sites (n=322 successful dives). The dominant prey type observed was clam (38%); mussel and crab were 14% and 2%, respectively, of the total sample. Size classes were estimated for 230 clams and the median size class consumed by sea otters was >3cm and ≤5cm; shells were discarded rather than ingested.

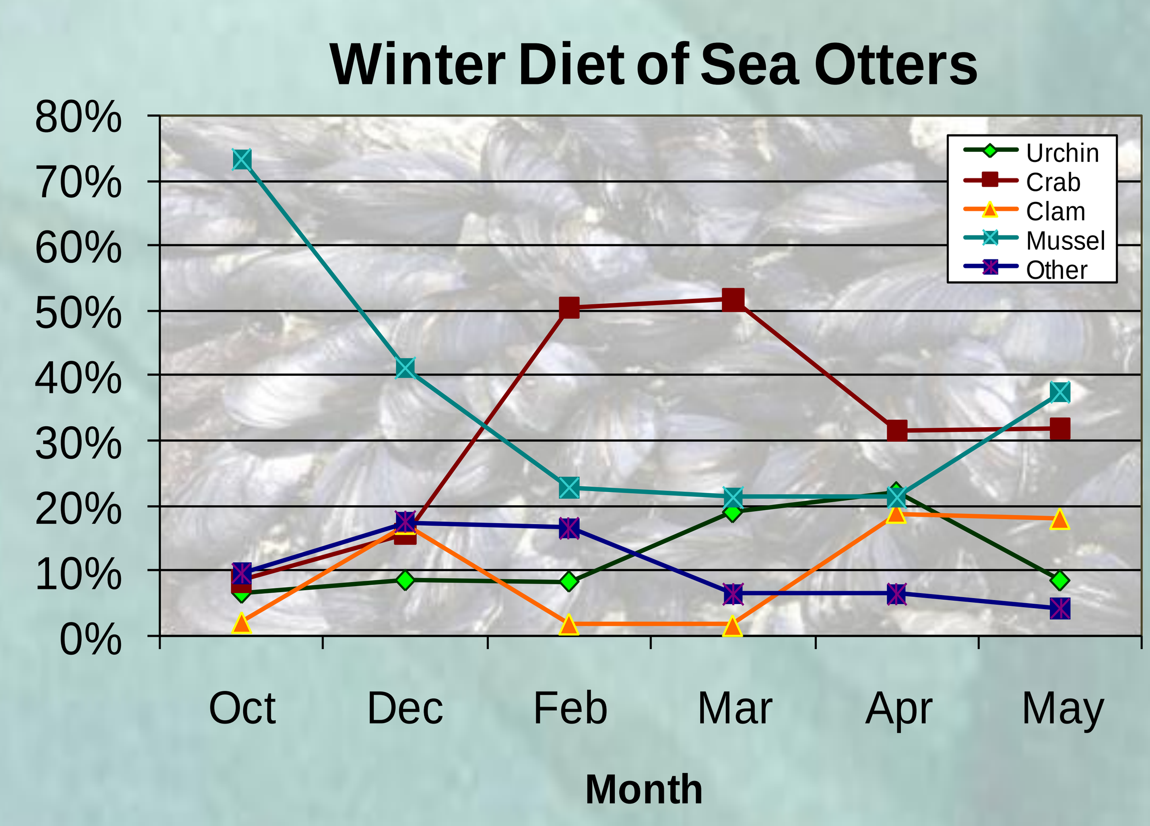

Figure 2. Mean percent volume of prey type found in sea otter scats collected during October 2008-May 2009

DISCUSSION

Kachemak Bay is largely a soft-sediment habitat and has the potential to support large populations of high-calorie sea otter prey such as clams and crabs. To fully understand the relationships between sea otter foraging and the benthic ecosystem in Kachemak Bay, multiple methods will need to be employed. Scat analysis is strongly biased toward ingested hard parts of prey and, in the case of clams, understates the contribution of larger sized clams in the diet. In contrast, visual observations are limited to the nearshore foraging habitat and are biased against prey consumed > 1km from shore, which may include the larger species of crab.

Example of sea otter scat

Visual Observations

In 2007, the U. S. Fish and Wildlife Service initiated a study of 44 radio-marked sea otters in Kachemak Bay. Figure 3 illustrates the cumulative distribution of winter foraging locations. Assuming that marked animals were representative of the whole population, foraging occurred in proximity to haul out sites as well as in open water. Emerging techniques in isotope studies of sea otter whiskers will likely be an important tool in understanding diet in habitats like Kachemak Bay.

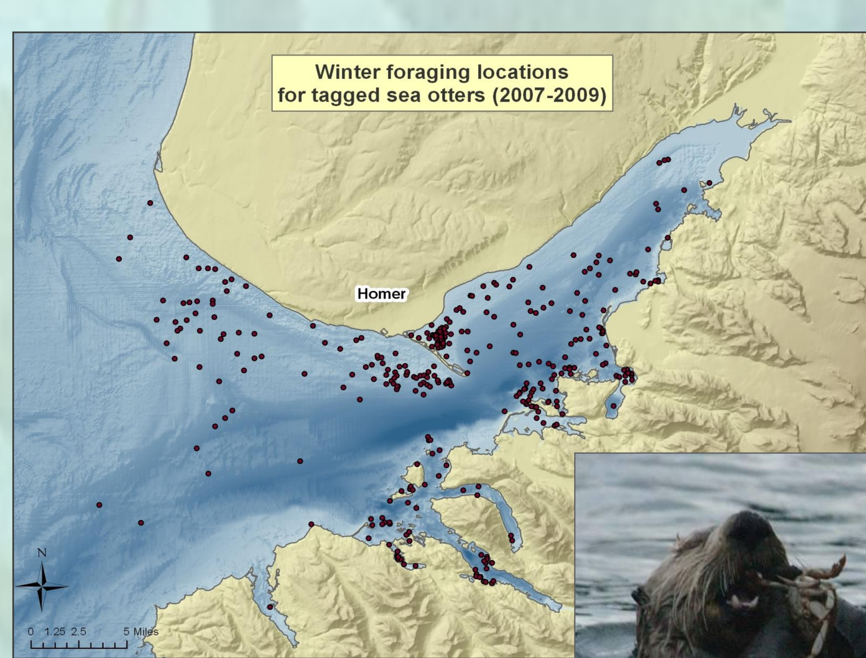

Figure 3. Cumulative distribution of winter foraging locations of 44 tagged sea otters in Kachemak Bay, Alaska

FUTURE DIRECTIONS

Scat analysis will be a useful tool to identify trends in specific prey, such as crab, over time in Kachemak Bay. Crab parts, even those that are well-masticated, are identifiable in the scat samples and include a range of species - from the small intertidal and subtidal species to the larger tanner crabs. In future monitoring, we will: 1) develop tools for the positive identification of crab species in the winter diet, and 2) monitor the trend in consumption of crab over time within a season and among years. Human use of crab is managed by the Alaska Department of Fish and Game. A better understanding of the effects of both human use and a keystone species foraging on crab populations will facilitate a comprehensive management of harvestable crab species.

Acknowledgements:
We would like to thank all of the volunteers who collected and sorted sea otter scats in 2008 and 2009: Steve Baird, Weatherly Bates, Ingrid Harrald, Bob Hartley, Karen Shemet, Debbie Tobin, and Kristin Worman. We thank Carmen Field who provided assistance in prey identification and poster review and the USFWS, specifically, Verena Gill and Doug Burn for project support.

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